NGST Systems Engineering Report

Thermal Subsystem 01

Title: **System Level Thermal Analysis Results from Fall 1997 Quarterly**	
Date: 5/4/98	Number: THSER01
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References: 1. M. Choi/GSFC, “NGST Thermal Analysis, Quarterly Review, “ presentation, 10-9-98 2. R. Schunk/MSFC,”OTA Thermal Analyis Results”, presentation, 10-9-98 3. D. Neuberger/Swales, “NGST Thermal Analysis Report, 10-4-98	

Description

This report summarizes the more significant results of various thermal trade studies and results performed in the Fall of 1997. The referenced reports and presentations include more details and results from less significant trade studies. The trades examined top level NGST observatory and sunshield configuration scenarios to better understand the various parameters effecting thermal performance such that a baseline shield configuration could be chosen.

Sun Shield Results Summary

Results are presented throughout the attached figures and graphs. The primary impact of the thermal studies resulted in an updated sunshield baseline configuration consisting of six layers instead of four. Sunshield analyses resulted in a new post quarterly NGST yardstick shield baseline as indicated in Table 1. The most significant result of the study was the descision to maintain parallel layers in the NGST yardstick design versus the incorporation of a ‘v-groove’ shield configuration. It was felt that additional parallel layers could perform as well as a the incorporation of ‘v-groove’ into the baseline four layer design to maintain the OTA below 50 K.

Detailed Discussion

All sunshield thermal trade parametric studies assumed an initial baseline thermal configuration as follows: four sunshield layers, black Kapton shade layer facing OTA, low a/e conductive composit coating on layer facing sun, a non-conductive, i.e. glass, primary mirror, low emittance coating on primary mirror reaction structure, parallel shield layer, and diffuse radiation between layers. The impact of significant configuration parametric analyses are as follows.

Additional layers. As Figure 1 illustrates, adding additional layers reduces OTA temperatures. Four, six, and eight layers, were analyzed with the total shield thickness staying the same. Although, there were more layers, the spacing between the layers was reduced. Perfomance would have been better if the shield thickness could have been expanded such that the layer spacing could have remained constant . The effect of the number of layers was also examined with a much higher a/e coating on the sun facing layer side, bare Kapton. Although the sun side shield layer runs significantly hotter, overall OTA temperatures are only mildly effected with a 3 K to 5K increase in primary mirror temperature.

Table 1 Major NGST System Level Thermal Parameters, Pre and Post Fall '97 Quarterly

Parameter	Pre-Fall 97 Quarterly	Post-Fall 97 Quarterly
Number of Sunshield Layers	4	6
Layer spacing	0.15 m between layers 1/2, 3/4 0.30 m between layers 2/3	.075 m between layers 1/2, 2/3, 4/5, 6/7. 0.30 m between layers 3/4
Layer configuration	Parallel	Parallel
Emittance of layer facing OTA	0.7	0.03
Reaction structure emittance	.03	.7
Radiation between layers	Diffuse	Diffuse
Sun facing layer	Low a/e conductive composite, eol a/e = .4/.62	ITO Kapton, eol a/e = .63/.65

Emittance of shade layer facing OTA Figure 2 illustrates the effect on OTA temperature if the emittance of the OTA facing layer is lowered to that of VDA (e = .03). This compares somewhat to adding a fifth layer. Results indicate that for a four layer system, the OTA temperature is lowered considerably. It is speculated that with a six or eight layer system, the results would be

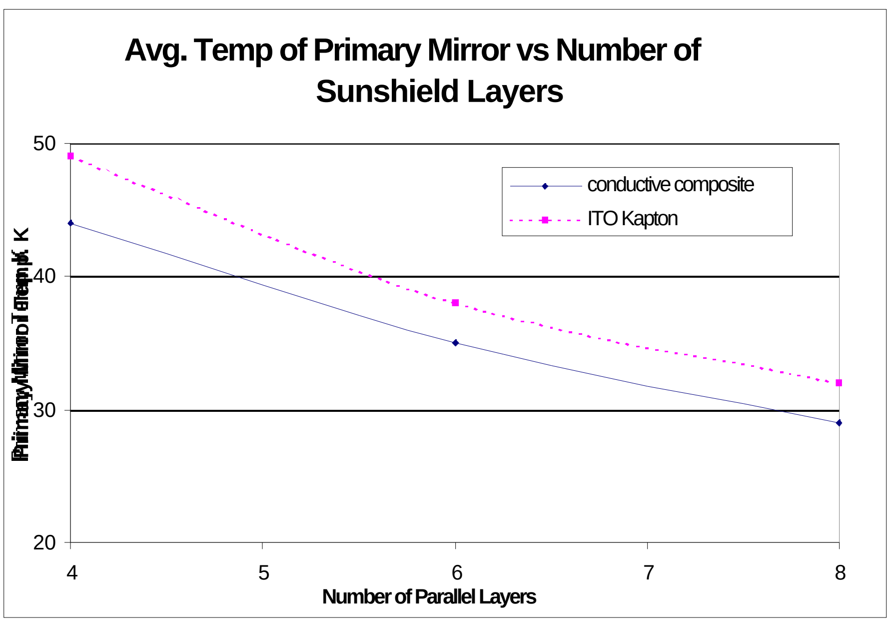

Figure 1 Effect of Number of Shield Layers on Primary Mirror Temperature

less dramatic due to higher attenuation of the shield. Because of NGST's unique orbit and configuration among space based telescopes, stray light analyses indicate that a highly reflective surface facing the OTA is acceptable.

Effects of shield ‘v-groove’ on OTA. Figure 3 illustrates the effects of creating an angle between layer pair 1 and 2 with respect to layer pair 3 and 4, referred to as a ‘v-groove.’ This basically creates a wider gap between the layer pairs allowing more energy to escape to space. This study also compared the effects of diffuse versus specular properties of the membranes. Results indicate that introducing just a small angle between the layers yields a considerable drop in OTA temperature. Continueing to increase the angle yields even colder temperatures, but the effectiveness begins to diminish. It should also be noted that this study only looked at introducing an angle between pairs of shade layers. It is speculated that additional benefit would be realized if each of the layers were angled with respect to each other.

Assuming fully specular properties results in lower OTA temperatures because energy is reflected from between the layers more efficiently before it is absorbed. Since the actual amount of membrane specularity cannot at this time be fully quantified due to all of the unknowns associated with the sunshield, baseline NGST thermal analyses will continue to assume diffuse properties for design conservatism. It is hoped that the amount of actual specularity can be quanitified as the design of NGST develops such that it can be introduced into the baseline thermal analyses.

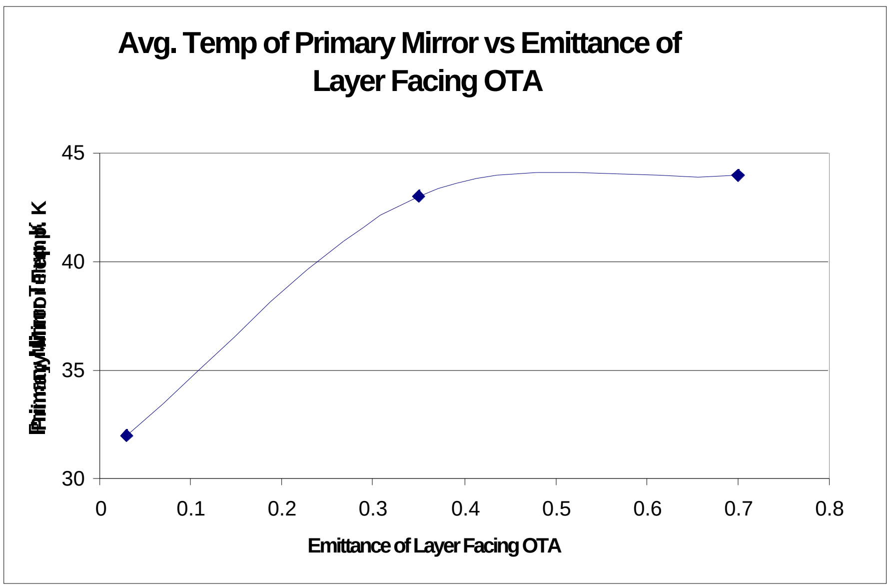

Figure 2 Effect of OTA Facing Layer Emittance on Primary Mirror Temperature

Sun facing layer thermal coatings. As illustrated in Figure 1, the temperature of the sun facing membrane layer does have a small but considerable impact on OTA temperatures. Thus, it is desireable to have as low an a/e coating as possible on the sun facing layer. While silverized Teflon exibits excellent optical properties and would be an excellent candidate for such an application, domented degradation of the Teflon outer layers on the Hubble Space Telescope indicates that Teflon may not be a suitable substrate for a long duration mission like NGST. Pre-quarterly analyses assumed a candidate low a/e coatings such as the conductive composite coating under development at the Goddard Space Flight Center. Until Teflon is fully qualified for a mission like NGST or other promising candiate materials undergo enough testing to gain confidence in their possible use, NGST thermal analyses will assume bare Kapton as the sun facing layer. Although the high a/e ratio of bare Kapton will most likely cause thermal control issues for the spacecraft bus, assuming its use adds conservatism and margin to the study phase OTA thermal analyses.

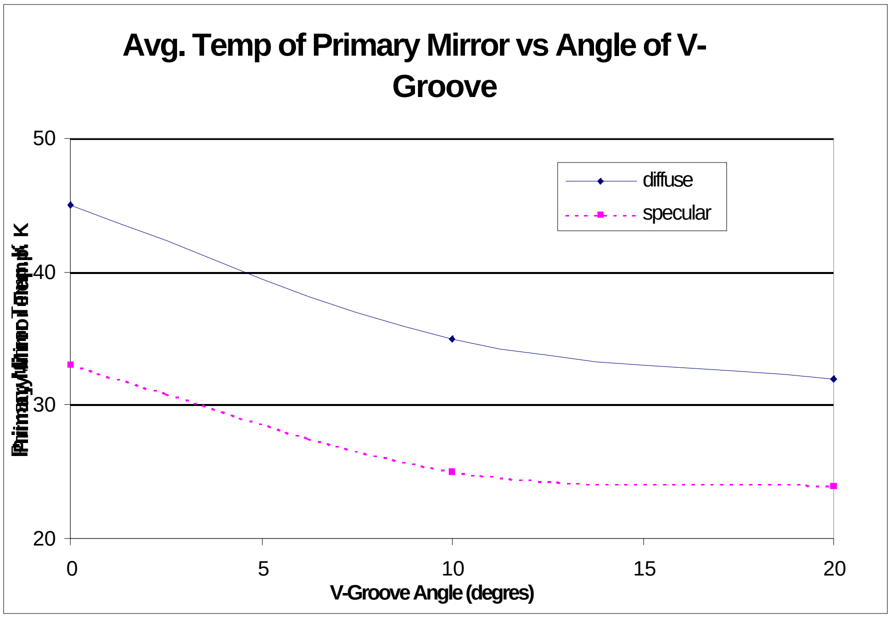

Figure 3 Effect of V-Groove on Primary Mirror Temperature